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A Theoretical and Empirical Analysis

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Abstract

Consistent with more general findings of psychological research, account-
ing studies have reported that auditors do not process information configur-
ally. Based on these studies, the conventional wisdom has become that audi-
tors' judgment policies may be represented adequately by simple-form (i.e., main
effects) linear models. This paper challenges such conventional wisdom by
showing that extant psychological and accounting studies have certain common-
alities which limit the ability to detect configurality and that experimental
results in these studies were interpreted in a problematic fashion. Contextual
and (to a lesser extent) cognitive factors are used herein to develop a con-
ceptual framework for configural information processing, as well as a basis for
more appropriate interpretation of results. Subsequently, an experiment is
reported in which a theory-directed empirical search for configural processing
was conducted. Contrary to the conventional wisdom, but consistent with the
conceptual framework, substantial evidence of auditors' configural information
processing is reported. The foregoing are discussed both from audit research
and audit practice perspectives.

CONFIGURAL INFORMATION PROCESSING IN AUDITING:
A THEORETICAL AND EMPIRICAL ANALYSIS

Considerable research has been conducted on how and how well auditors, accountants and others using accounting information formulate judgments and make decisions (see Ashton [1982,1983] and Libby [1981] for reviews). Both psychology and accounting researchers focussing on the former (how) issue have investigated whether such judgment/decision making is characterized primarily by independent or patterned cue usage. In the judgment/decision making litera-ture, independent cue usage is known as linear information processing and patterned cue usage is known as configural information processing. While a variety of research approaches can and have been used to investigate this issue, the predominant approach has been to employ Brunswik's Lens model (LENS), especially in concert with analysis of variance (ANOVA). These studies generally find that the overwhelming majority of the explained judgment vari-ance is attributable to main effects (i.e., independent or linear information processing). Moreover, little, if any, explained variance generally has been attributed to cue interaction effects (i.e., patterned or configural informa-tion processing).[1]

The conventional wisdom within the accounting/auditing literature, there-fore, has become that information processing may be represented by simple-form compensatory models (i.e., main-effect models) because auditors and others using accounting information do not appear to exhibit significant configural information processing.[2] To challenge such conventional wisdom, this paper: 1) critically analyzes how extant studies have attempted to measure configurality and interpret experimental results, 2) presents a context-specific conceptual framework for configural information processing and 3) demonstrates, by describing the results of a theory-directed laboratory experiment, how the insights from (1) and (2) can be employed to identify auditor configural

information processing. Since much of the prior auditing research has been set in the context of internal control evaluation, the conceptual framework for configural processing is developed within that context and the laboratory experiment employs experienced auditors as subjects. Thus, consistent with Libby, Artman and Willingham [1985], we employ the contingent nature of relationships within internal control contexts and auditors' knowledge of such relationships to develop our configural information processing conceptual framework. Irrespective of our specific context, however, much of what is presented is quite general and thus, is applicable to other auditing tasks (e.g., analytical review and evidence evaluation).

Consistent with hypotheses derived from the conceptual framework, the laboratory experiment produced evidence that at least some auditors process information configurally. Thus, when the search was guided by theory and experimental results were appropriately interpreted, configural information processing was identifiable. These results, as discussed below, have significant implications for evaluating how and how well auditors process information, as well as for the development of computer-based models of auditor's judgment/ decision making (e.g., expert systems).

The next section of this paper presents a review of prior configural information processing research in psychology and accounting/auditing, while the third section discusses issues associated with measurement and interpretation of configural information processing. A conceptual framework for configural processing in the audit context of internal control evaluation is presented in the fourth section. The fifth section describes the laboratory experiment and presents the experimental results while the final section contains concluding remarks including discussion of the research and practice implications of the experimental results.

Extant Configural Information Processing Research

Research on configural processing has been reported in both the psychology and accounting literatures. The purposes of this section are to more fully describe configural information processing and briefly review the findings of these studies, thus providing the background for subsequent theoretical and empirical work.

Psychological Research on Configural Information Processing

The notion of configural processing was discussed in the psychology literature at least as far back as the early 1900s (Thorndike [1918]). It was not until the 1950s, however, that pyschologists (Meehl [1954, 1985, 1959]) began to report experimental investigations of configural information processing. These early investigations are noteworthy from several perspectives, two of which are germane to the present discussion. First, they provided the working definition of configurality which commonly underlies psychologial investigations of configurality. That is, configurality is cognition in which the pattern (or configuration) of stimuli is important to the subsequent judgment/decision. Although typically discussed in connection with information combination, such cognition could be employed during any judgment phase including information search and feedback/learning (see Einhorn, Kleinmuntz and Kleinmuntz [1979]).

Second, the early psychological investigations provided initial experimental results on configurality and appear to have stimulated/guided substantial research efforts during the 1960s and 1970s with respect to configurality (see Hammond and Summers [1965], Goldberg [1968], Slovic and Lichtenstein [1971] and Slovic, Fischhoff and Lichtenstein [1977] for reviews). These studies reported that experts often view configural cue usage to be an

important component of their judgment formation. However, across a wide variety of experimental judgment contexts and tasks, psychologists have found only limited evidence of its presence. It is not surprising, therefore, that psychologists' interest in configural information processing continued into the 1980s (see Anderson [1981], Camerer [1984, 1987] and Edgell [1980, 1983]).

This conflict between what judges report and experimental findings is probably no better illustrated than by the investigation of physicians' diagnoses of benign vs. malignant gastric ulcers reported by Hoffman, Slovic and Rorer [1968]. In this now classic ANOVA study, despite being assured by radiological experts that configural processing was essential for correct ulcer diagnosis, the authors found that interaction terms only accounted for 10% of the physicians' explained variance. Additionally, they reported that the largest main effect typically explained 10 to 40 times as much total variance as the largest interaction. Such an outcome was interpreted as evidence of the power of linear models (Dawes and Corrigan [1974]) and the absence of significant configural cue usage.[3]

While psychology studies generally have failed to detect configurality, there are a few exceptions. Examples in which configurality was reported include studies of stockbrokers' judgments (Slovic [1969]), psychiatric medical professionals (Rorer, Hoffman, Dickman and Slovic [1967]), and studies of moral judgment (Leon, Oden and Anderson [1973]). Similarly, Einhorn et al. [1979] have noted that process-tracing models suggest that information search often is configural. However, whether considering overall judgments or judgment phases such as information search, the key points, as discussed more fully below, are that configural cognition involves cue patterns rather than individual cues and that the typical report has been that human cognition is not configural.

Accounting Configural Information
Processing Research

Configural information processing attracted the attention of early be-

havorial accounting researchers who worked within the policy-capturing paradigm

and like their psychological predecessors, employed ANOVA designs and the LENS

model (see, Ashton [1982, 1983] and Libby [1981] for reviews). Consequently,

following the lead of psychological studies, the accounting studies searched

for evidence of configural cue usage by examining the statistical significance

of the explained variance attributable to interaction terms.[4] The results of

the accounting studies were similar to the psychology studies; while some

small, but statistically significant interactions sometimes were noted, the

typical report was that main effects accounted for the overwhelming majority of

explained variance. Moreover, such results were interpreted as evidence of

non-configural information processing.

The series of papers on auditors' evaluation of internal controls is a

prominent example of this research. The first such paper was reported by

Ashton [1974]. While many extensions have been reported (e.g., Ashton and

Kramer [1980], Ashton and Brown [1980], Hamilton and Wright [1982], Reckers and

Taylor [1979], Hall, Yetton and Zimmer [1982] and Trotman, Yetton and Zimmer

[1983]), all of these studies offered essentially the same conclusion:

> " . . . on average the six main effects accounted for 80 percent
> of the variance in the auditors' judgments, and the 15 interactions
> accounted for only six percent. This suggests that the auditors
> acted as if they did not rely on interactive, or configural, infor-
> mation processing (Ashton [1983, p. 17])."

A similar lack of explained variance by interactive terms, has been

reported in other accounting studies for which the experimental task and

context were different. For example, Brown [1983] reported that interactions

accounted for only 5 percent of the variance in auditors' evaluations of

internal audit departments and Libby [1975] found substantial linear

predicability for discriminant models constructed to represent commerical loan officers' bankruptcy predictions.

Configurality Measurement

Discussed in this section are: 1) configurality measurement within the ANOVA/LENS model, 2) issues relating to the employment of this model for the purpose of measuring configural information processing and 3) issues germane to appropriate interpretation of the results of experimental investigations of configurality. In particular, it is argued that when studying configural information processing, one should: 1) have expectations concerning specific cue interactions, including the nature (form) of such interactions, 2) employ research designs capable of effectively detecting expected interactions, 3) be aware of the theoretical maximum size (given their form) of the potential interactions and 4) be cognizant of the potential effects of ignoring small interactions on judgment error costs. While such issues and arguments previously have appeared in the psychology literature (and to some extent in the accounting literature), the present discussion is intended to increase their salience and thereby, make a definitive case for measures of configurality (in addition to those employed previously) to guide the interpretation of results.

Configurality Measurement
Within the ANOVA/LENS Model

Since much of the research on configural information processing was conducted by employing ANOVA designs and the LENS model within the "policy capturing" paradigm (see Libby [1981]), the ensuing discussion is presented from this perspective. In an ANOVA framework main effects reflect linear information cue utilization while interactions have been viewed as the primary manifestation of configural information cue utilization. A significant interaction indicates that the effect of an information cue on a judgment/

decision depends upon the level of another information cue. Interactions can be categorized by the relationship between their constituent information cues and the judgment/ decisions: either conditionally monotonic or not. Conditionally monotonic relationships require that higher (or lower) values of one constituent cue imply higher (or lower) judgment/decision values, regardless of the values of the other constituent cues (see Dawes and Corrigan [1974]). Interactions that are conditionally monotonic are referred to as ordinal, and those interactions that violate conditional monotonicity are referred to as disordinal (cf., Kerlinger [1986]).

To illustrate, consider a situation in which a judgment (with continuous values ranging from low to high) is made based upon two information cues, X_a and X_b, each having two levels, presence (level 1) and absence (level 2). Five examples of two-cue interactions are depicted in Figure 1. Panel A of Figure 1 presents two forms of positive ordinal interactions, while two forms of negative ordinal interactions are depicted in Panel B. A disordinal interaction is illustrated in Panel C. Notice that in the ordinal interaction examples, the effect on judgment of one information cue may be amplified (Panel A) or compensated for (Panel B) by the existence of a second cue. For example, looking at the positive ordinal interaction in the left side of Panel A, when cue X_a is absent (level 2), the presence or absence of cue X_b has little effect on the judgment. However, when cue X_a is present (level 1), the judgment is greater when cue X_b also is present (level 1) than when X_b is absent (level 2). Thus, when both are present, X_b amplifies the effect of X_a on the judgment.

Analogously, looking at the negative ordinal interaction in the left side of Panel B, when cue X_a is present (level 1), the presence or absence of cue X_b has little effect on the judgment. However, when cue X_a is absent (level 2), the judgment is greater when cue X_b is present (level 1) than when X_b is absent

(level $\underline{2}$). Thus, the presence of cue X_b compensates (in this example, partial-
ly) for the absence of cue X_a. In the disordinal interaction example (Panel
C), a greater judgment may be obtained with the presence (level $\underline{1}$) or absence
(level $\underline{2}$) of cue X_a, depending on the level of the other information cue.
Thus, the effect of one information cue is reversed by the second cue in a
disordinal interaction.

<div align="center">INSERT FIGURE 1 ABOUT HERE</div>

Representative Design

A popular way of achieving information cue orthogonality, required by
ANOVA, is to construct all possible combinations of categorical cue levels in a
completely-crossed factorial design.[5] A potential problem with such factorial
designs, however, is the extent to which experimental information cue patterns
are representative of ecological (naturally occurring) information cue patterns
(see Hammond and Stewart [1974], Libby [1981] and Trotman and Yetton [1985]).
When experimental cue patterns are not representative of ecological patterns,
ANOVA results, particularly those intended to represent configural information
processing, are difficult to interpret and generalization of those results
would not be appropriate.

There are two possible threats to design representativeness: plausiblity
and frequency. Interpreting experiments as structured conversations between
subjects and experimenters, Kahneman and Tversky [1982] speculated that sub-
jects come to experiments with the expectation that experimenters are "coopera-
tive." But when experimenters employ ecologically implausible information cue
combinations (or cues set at implausible levels), the experimenters' coopera-
tiveness may become suspect. For example, a combination of information cue
levels that, by definition, cannot occur in the ecology could cause individuals
to react, questionning the experimenter's motives. Such reaction could

contaminate individuals' judgments of all subsequent information cue combinations (even though themselves plausible), casting doubt on the meaningfullness of any ANOVA results.

ANOVA assumes that information cue combinations occur with equal frequency. In the ecology, however, cue combinations generally have unequal frequencies. What, then, are the consequences of non-representative frequencies? In the extreme, the consequence could be the same as the implausiblity effect discussed above. To illustrate, an information cue combination that has an expectation of occurring once out of 100 times in the ecology, but for design purposes occurs once out of four times in the experiment, may cause reactions by individuals in which they begin to question the experimenter's motives. Assuming frequency nonrepresentativeness is not so large that judgments are affected, a serious problem still could arise. That is, the explained variance attributed by ANOVA to an information cue combination could be seriously misestimated. For example, the ability of a cue combination to explain judgment variance would be substantially understated when the combination only occurs in the experiment once out of 32 times, but in the ecology it occurs eight out of 32 times. Again, in such situations it would be inapproprate to generalize the ANOVA/LENS model results, particularly with respect to configural cue usage.

Detection of Effects Using
ANOVA/LENS Methods

The search for interactions is likely to meet with failure without theory concerning the particular interactions one should expect (Hoffman, 1968). As the complexity of the decision context increases (i.e., the number of dimensions or terms increase), the problem of parameter estimation also increases, to the point that interactions, without a priori expectations, become very difficult to detect. A basic problem with ANOVA/LENS model accounting studies,

therefore, is that no such study provided a priori expectations for specific
information cue interactions. Indeed, some studies simply expanded the number
of information cues under the assumption that the chances of detecting con-
figural processing would be increased.

Detection of configural information processing is especially difficult
when the expected information cue interaction is ordinal. Yntema and Torgerson
[1961], for example, have shown that even when information processing strate-
gies are known to be configural, ANOVA models will attribute most of the ex-
plained variance to main effects rather than ordinal interactions. This result
is closely related to the well-known "robustness" of linear models (see Dawes
and Corrigan [1974]). As demonstrated in Appendix A, the theoretical limit to
the magnitude of an ordinal interaction's explained variance (without changing
the form of the interaction) is the explained variance of the constituent
factor that is compensating or amplifying the effect of the other constituent
factor. Further, the explained variance attributable to an ordinal interaction
is at a maximum when such factor's compensation or amplification is complete
(e.g., the effect of a low level of one cue is completely compensated for by a
high level of another cue), and at that maximum the total explained judgment
variance is equally distributed between the interaction and its constituent
factors. Thus, in most ecological situations, the explained variance of an
information cue interaction will be small relative to that of its constituent
cues. Many accounting ANOVA/LENS model studies, however, have reacted to such
a finding as if it were sufficient evidence that individuals do not process
information configurally.

Interpretation of ANOVA/LENS Results

An ubiquitous caveat is not to interpret significant main effects without
first interpreting significant interactions that include those factors. The

reason for this caveat is that interaction effects lead to a qualification on the associated main effects. Overall estimates of the effect of one factor may be good predictors of _average_ effects over all possible levels of the other factors. But such estimates are not necessarily good predictors of the effects to be expected when significant (albeit small) interactions exist. Some accounting ANOVA/LENS model studies, however, upon finding that the judgment variance attributable to information cue interactions is small, have concluded that judgments can be adequately predicted by simple linear (main effect) ANOVA models.

The importance of information cue interactions is less a function of their relative explained judgment variance, and more a function of the costs associated with increased prediction errors if the interactions were to be omitted. Omitting even relatively small cue interactions from a prediction model could result in large increases in error costs. Given, for example, a negative ordinal interaction of the form represented in the left hand side of Figure 1 (with the dependent variable being control reliability), the omega-squared statistics would be approximately 48%, 30% and 6% for the cue X_a, cue X_b and two-cue interaction, respectively.[6] However, if the observations were to be "predicted" using a simple-form (main-effect) linear model, control reliability would be understated by approximately 8% when given the cue combination (X_{a2}, X_{b1}) and would be overstated by approximately 17% when given the cue combination (X_{a2}, X_{b2}). Thus, the simple-form linear model could result in significantly greater error costs than a linear model that incorporates the effects of cue interaction (even if such interaction were small when expressed as a percent of total judgment variance). Further, since the costs associated with different prediction error types are asymmetric in this situation (i.e., understatement of control reliability implies a threat to audit efficiency,

whereas control reliability overstatement implies lower audit effectiveness), control reliability overstatement could have even greater cost consequences. The implication is that conclusions concerning the importance of significant, although small interactions produced within ANOVA/LENS models may not be appropriate when based exclusively upon the percent of judgment variance which they explain.

Supplemental Configurality Measures

As guides for interpreting ANOVA configurality measures (e.g., omega-squared statistics), two supplemental measures are introduced in this sub-section.[7] Recognizing that the judgment variance attributable to ordinal interactions can be adversely affected by the assumption of equally occurring treatments and by theoretical limits to ordinal interaction magnitudes, the supplemental measures address the extent of compensation or amplification as a percent of the interaction's theoretical maximum (i.e., the maximum possible without changing the form of the configural relation). As will be apparent, these supplemental measures are Euclidean in origin. That is, these measures are derived from a n-dimensional graph of the relevent interactions. As such, they provide a quantification of what otherwise would require a visual inspection of the form of the underlying interactions.

Consider, for example, a situation in which individuals form a judgment (J) on the basis of two information cues (A and B), each cue having two quali-tative levels (present [y] and absent [n]). A configural relation between the two information cues and an individual's judgment is ordinal when the algebraic signs of the slopes of the lines that describe cue A's effects on judgment, given each level of cue B, are not different (i.e., as indicated earlier, the levels of both cues are monotonically related to individual's judgments). The

presence of an ordinal relation, therefore, can be identified using the following inequality:

$$[J(A_yB_y)-J(A_nB_y)] / [J(A_yB_n)-J(A_nB_n)] > 0, \tag{1}$$

where $J(\ )$ represents an individual's judgment given the cue combination in parentheses and neither the numerator nor the denominator equal zero.[8] When (1) does not hold the configural relation between cue levels and judgments is either none ($= 0$) or disordinal (< 0).

Assume that (1) indicates an ordinal configural relation exists. Whether that relation is negative (compensating) or positive (amplifying) can be determined using the following inequality:

$$J(A_yB_y)-J(A_yB_n)-J(A_nB_y)+J(A_nB_n) < 0. \tag{2}$$

When (2) holds the implied ordinal relation is negative, and when (2) does not hold the implied ordinal relation is either none ($= 0$) or positive (> 0).

Figure 2, Panel A, contains contains a graphical illustration of a situation in which there is a negative ordinal relation between cue levels and judgments. In such a situation, the extent to which the presence of cue B compensates for the effect on judgment J of cue A's absence is measured by the following distances (in Figure 2, Panel A, these distances are labeled D_1 and D_2, respectively):

$$D_1 - D_2 = [J(A_nB_y)-J(A_nB_n)] - [J(A_yB_y)-J(A_yB_n)]. \tag{3}$$

Assuming cue A's effect on judgment <u>given cue B's absence</u> is not changed, the maximum compensation theoretically possible, without changing the form of the configural relation from negative ordinal to someother form, can be determined. This theoretical maximum compensation would be the distance given in (3) plus the distance $J(A_yB_y)-J(A_nB_y)$, which in Figure 2, Panel A, is labeled D_3. A measure of the theoretical maximum compensation is:

$$D_1 - D_2 + D_3 = [J(A_nB_y)-J(A_nB_n)] - [J(A_yB_y)-J(A_yB_n)] +$$

$$[J(A_yB_y)-J(A_nB_y)],$$

$$= J(A_yB_n) - J(A_nB_n). \qquad (4)$$

Thus, a measure of the extent to which cue B's presence compensates for the effect on J of cue A's absence, as a percent of the theoretical maximum, is:

$$\frac{D_1 - D_2}{D_1 - D_2 + D_3} = \frac{[J(A_nB_y)-J(A_nB_n)] - [J(A_yB_y)-J(A_yB_n)]}{[J(A_yB_n) - J(A_nB_n)]}. \qquad (5)$$

As its numerator approaches zero (i.e., no compensation exists), (5) approaches zero, and as its numerator approaches the theoretical maximum compensation, (5) approaches one. Within this interval the compensation measure given in (5) is monotonically related to ANOVA measures of explained judgment variance (e.g., omega-squared statistics). The compensation measure, however, is not affected by certain factors that affect the ANOVA measures.[9]

Figure 2, Panel B, contains contains a graphical illustration of a situation in which there is a _positive_ ordinal relation between cue levels and judgments. In such a situation, the extent to which the presence of cue B amplifies the effect on judgment J of cue A's presence is measured by the following distances (in Figure 2, Panel B, these distances are labeled D_1 and D_2, respectively).

$$D_1 - D_2 = [J(A_yB_y)-J(A_yB_n)] - [J(A_nB_y)-J(A_nB_n)]. \qquad (6)$$

Again, assuming cue A's effect on judgment given cue B's absence is not changed, the maximum for such amplification, without changing the form of the configural relations from positive ordinal to someother form, would be the distance given in (6) plus the distance $M-J(A_yB_y)$ where M is the response range maximum value (in Figure 2, Panel B, this distance is labeled D_3). A measure of the theoretical maximum amplification, therefore, is:

$$D_1 - D_2 + D_3 = [J(A_yB_y)-J(A_yB_n)] - [J(A_nB_y)-J(A_nB_n)] + M - J(A_yB_y),$$

$$= [M-J(A_yB_n)] - [J(A_nB_y)-J(A_nB_n)]. \tag{7}$$

Thus, a measure of the extent to which cue B's presence amplifies the effect on judgment J of cue A's presence, as a percent of the theoretical maximum, is:

$$\frac{D_1 - D_2}{D_1 - D_2 + D_3} = \frac{[J(A_yB_y)-J(A_yB_n)] - [J(A_nB_y)-J(A_nB_n)]}{[M-J(A_yB_n)] - [J(A_nB_y)-J(A_nB_n)]}. \tag{8}$$

As its numerator approaches the theoretical maximum, (8) approaches one, and as its numerator approaches zero (i.e., no amplification exists), (8) approaches zero. Within this interval the amplification measure represented by (8) is monotonically related to ANOVA measures of explained judgment variance (e.g., omega-squared statistics). The amplification measure, however, is not affected by certain factors that affect the ANOVA measures.[10]

Configural Cue Utilization: A Conceptual Framework

As noted earlier, the search for configurality is not likely to be suc-cessful unless one has a theory to guide that search. Upon reflection, it is intuitive that such a theory should be contextually based. That is, the sub-stantive content of specific situations and tasks must be logically analyzed to determine if configural information processing should be employed by indivi-duals making decisions and judgments within those situations and tasks. Beyond such a contextual base, a cognitive theory is required which would predict the conditions under and the extent to which individuals will use configural infor-mation processing when such processing is appropriate. Such a cognitive theory, as discussed below, would involve human learning, memory and expertise, as well as environmental aspects that affect such cognitive processes.

Unfortunately, most accounting/auditing studies of configural processing, like early psychological studies, essentially conducted unguided searches since

there was no obvious (explicit) consideration given to what configurality would
mean in the specific accounting/auditing contexts in which they were set. In
the present section, therefore, configurality is discussed within the context
of a specific auditing task, internal control evaluation, thereby developing an
initial conceptual framework for configural processing in auditing contexts.
This framework is then used in subsequent sections to guide the present search
for auditors' configural cue utilization.

Configural Processing Within
An Auditing Context

While internal control evaluation largely is a subjective task about which
researchers still know little, there are a few general concepts which apparent-
ly guide such evaluations in practice. One such concept given the contingent
nature of internal control interrelationships (see Libby et al. [1985]) is
"compensating" or "mitigating" control while, to a lesser extent, another such
concept is "amplifying" control. Consider first that the auditor's primary
purpose in evaluating internal controls is to determine the risk that financial
statement amounts are presented accurately (i.e., in accordance with generally
accepted accounting principles). The basic logic, represented in the audit
risk model (AICPA [1983]) recognizes that the probability that a material
misstatement will be present in an auditee's financial statements is jointly
dependent on the propensity for errors and irregularities to occur which would
result in material misstatement (i.e., inherent risk) and the probability that
such errors and irregularities will not be either prevented or detected by the
auditee's system of internal controls.

Consequently, the auditor evaluates internal control to identify both
internal control strengths (which permit the auditor to modify the direct
financial statement tests which otherwise would have been performed) and

internal control weaknesses which suggest areas of potential heightened mis-
statement probability (Cushing [1974]). Of course, such potential may not be
realized because, for example, errors or irregularities may not have occurred
in the first place or there may be other controls present and operating which
compensate for the apparent weakness (see Bodnar [1975] and Meservy, Bailey and
Johnson [1986]).

To illustrate, consider a situation in which there is an internal control
weakness, such as the absence of adequate approvals over cash disbursements.
More precisely, assume that persons signing checks are not independent of those
approving check requests and preparing the checks. In such a situation, an
auditor should consider the type of errors or irregularities that can occur as
a consequence of this separation-of-duties control weakness, and whether there
are other controls in existence that compensate for the weakness.

Two classes of such controls are suggested by the above discussion: (1)
compensating preventive controls and (2) compensating detective controls. An
example of the former would be a requirement that all check requests be review-
ed and approved by two officials, at least one of whom is independent of the
person initiating the check request. Such a control likely would lead to iden-
tification of improper check requests on an ex ante basis and thereby, prevent
a misstatement from appearing in the financial statements. An example of a
detective control is provided by an internal audit feature that results in ex
post verification of the validity of such cash disbursement transactions.
Notice that such a control increases the likelihood that the misstatement, if
present, will be detected rather that preventing the misstatement from appear-
ing in the financial statements. Thus, all other things equal, preventive
controls should be perceived as more powerful (i.e., greater compensators/
amplifiers) than detective controls.

The effect of compensating controls in an ANOVA framework can be illustrated using the above example. Consider a case in which there are two controls, separation-of-duties (X_a) and dual check signers (X_b). Assume further that each control has two levels; either it is present and operating effectively (level $\underline{1}$) or it is not present (level $\underline{2}$). If the separation-of-duties control were present and operating effectively (X_{a1}), control reliablity would be judged as relatively high, regardless of whether the dual check signer control were present (X_{b1}) or not (X_{b2}). Alternatively, if the separation-of-duties control were not present (X_{a2}), control reliablity would be judged as relatively low in the absence of a compensating control. If however, the dual check signers control were present (X_{b1}) and were to compensate for the weakness created by the absense of the separation-of-duties control (X_{a2}), control reliablity would be judged as high as when the separation-of-duties control were present (X_{a1}), assuming full compensation, or would be judged as somewhere between the high and low levels, assuming only partial compensation.

Such a situation should be recognized as analogous to the negative ordinal interaction discussed earlier and illustrated in the left side of Figure 1, Panel B with the y axis reinterpreted to be control reliablity. Notice further that the slope of the line labelled X_{b1} depends upon the extent of compensation. Full compensation would be represented by a horizontal line while partial compensation would be represented by negative slope. Lastly, notice that the form of negative ordinal interaction depicted in the right side of Figure 1, Panel B (a "left-opening" negative ordinal interaction) does not make sense in the context of the present illustration since it would indicate that the maximum control reliability is achieved when neither control is present.

The effect of amplifying controls within an ANOVA framework may be similarly illustrated. First, recognize that the possibility for internal control

synergy (i.e., that two or more controls, in combination, may be more effective than would be implied by the sum of their individual effectiveness) is implicit in many textbook, CPA-firm manual, and research (see Bodnar [1975]) discussions of internal control reliability. This concept, however, is not as pervasive as compensating control and its explicit recognition only recently has been forthcoming. For example, the currently outstanding Exposure Draft of a new Statement on Auditing Standards on appraising control risk (AICPA [1987]) as well as recent studies by Grimlund [1982] and Srivastava [1986] recognize the importance of the control environment and the potential for interdependicies among controls in general as well as the potential that two or more controls together will enhance reliability more than the sum of their individual reliabilities.

Consider the same example as that employed earlier to illustrate compensating controls except now assume that control reliability is judged to be reasonably high when there is separation-of-duties (X_{a1}) but even higher when there is a redundant control (dual signatures) or a detective control (internal audit). In such a case, anticipation of the second control may effectively cause the original control procedures to be performed with greater care and frequency (see Bodnar [1975]) than otherwise would be the case. This type of situation is analogous to positive ordinal interaction depicted in the left side of Figure 1, Panel A with the same reinterpretation of the y axis as that above. Also similar to the above, notice that the form of positive ordinal interaction depicted in the right side of Panel B, Figure 1 (a "right-opening" positive ordinal interaction) does not make sense in the present context since it would mean that presence of separation-of-duties (X_{a1}) is detrimental when the dual check signers control is absent (X_{b2}).

Given the above discussion, an obvious question is, why has there not been evidence of configural processing in studies of internal control evaluation?

As the earlier discussion of configurality measurement suggests, we believe that there are several answers to this question, but a primary one involves the extent to which compensating or amplifying controls were present in the prior studies. When such controls are not included in an internal control evaluation case, there should be no expectation that subjects will exhibit configural information processing. Examining the instruments used in prior research, one observes that both preventive and detective controls are represented. However, it also is clear that no extant study captured two or more preventive control features which related to the same control objective in such a way that a weakness in one control would be at least partially offset by the presence of another control. Thus, there do not appear to be significant preventive compensating controls in prior studies. Further, while a detective control in the form of internal audit often is present in prior studies, that control generally is stated in a fashion so that the precise activities that internal audit was to have performed are not readily apparent. Consequently, it is not clear that internal audit would have been perceived as a significant detective compensating control in prior research. Finally, it is not obvious that any of the controls in prior studies would be perceived as amplifying another control. Again, when such controls are not present, significant configural information processing (at least that implying ordinal interactions) should not be expected of the evaluators.

The Laboratory Experiment

It has been argued above that significant configural information processing has not been observed in prior psychological and accounting/auditing judgment studies because: 1) the detection mechanism (typically ANOVA) has not been appropriately interpreted and 2) many such studies did not have a theoretical framework to guide the search for configurality (and thus, have not

incorporated cognitive and contextual factors that could affect individuals'
propensity for and ability to use configural information processing
strategies). In this section, we report a laboratory experiment designed to
address this argument.

Specificially, in addition to ANOVA, versions of the (earlier introduced)
supplemental configurality measures are used to aid interpretation of the ex-
perimental results. Further, the importance of contextual factors is recog-
nized by setting the experiment in an auditing context in which configural in-
formation processing is a central _a priori_ (normative) part of the required
judgment. The importance of cognitive factors is recognized to a limited
extent by using expert auditors as subjects (who have a greater propensity than
non-experts to have experienced the context and learned to use configural
processing; see related discussion in "Concluding Remarks" section below).
Finally, in designing the experiment, several steps were taken (discussed
below) to address potential representative design problems.

Hypotheses

Based on the earlier discussion of internal control risk evaluation, the
following alternative-form hypotheses were tested:

H1: The percent of internal control reliablity judgment variance explain-
ed by the interaction of an appropriate _preventive_ control with a
separation-of-duties control will be significantly greater than zero.

H2: The percent of internal control reliablity judgment variance explain-
ed by the interaction of an appropriate _detective_ control with a
separation-of-duties control will be significantly greater than zero.

H3: The percent of internal control reliabilty judgment variance explain-
ed by the interaction of an appropriate _detective_ control with a
separation-of-duties control will be significantly smaller than that
explained by the interaction of an appropriate _preventive_ control
with the same separation-of-duties control.

H4: An appropriate _preventive_ control will be perceived as either signi-
ficantly compensating for a separation-of-duties weakness or ampli-
fying a separation-of-duties strength.

H5: An appropriate _detective_ control will be perceived as either signifi-
     cantly compensating for a separation-of-duties weakness or amplifying
     a separation-of-duties strength.

H6: The extent of separation-of-duties weakness compensation (strength
     amplification) will be signficantly smaller for the _detective_ con-
     trol than for the _preventive_ control.

Null forms of the above hypotheses will be tested both in terms of the appro-

priate configurality measure (omega-squared statistic for H1-H3 or the supple-

mental configurality measures for H4-H6) and the proportion of subjects for

which the predicted relation holds.

An Internal Control Evaluation Case

Employing the conceptual framework presented earlier, a hypothetical

internal control evaluation case, was developed in which configural information

processing _should be_ employed by auditors. The background information for this

case is as follows:

> Assume you are a senior-level auditor and that one of your clients is
> Nortack Corporation. Nortack, a large processor of agricultural com-
> modities, is a privately-held company that has debt covenants requir-
> ing audited financial statements prepared in accordance with GAAP.
> The company has not presented significant auditing problems during
> your firm's tenure as its public auditor (the past five years). Nor-
> tack's management is actively involved both in designing the company's
> internal controls, as well as reviewing existing internal controls.
> The employees who administer Nortack's internal controls are well
> trained and supervised, with clearly defined responsibilities. Nor-
> tack has a relatively autonomous internal audit department that is
> adequately staffed and supervised; the department head was a manager
> for a Big-8 CPA firm, and most of the internal auditors have CPA
> certificates. During the past five years, Nortack has been computer-
> izing its accounting and information systems.
>
> Currently, you are planning Nortack's 1987 audit engagement and are
> evaluating its internal controls to determine the extent to which you
> will rely on them in planning the year-end audit work.
>
> For 32 randomly ordered cases, you will be presented with acompleted
> portion of the internal control questionnaire concerned with cash
> disbursement controls (completed, in each case, by an auditor on your
> staff). For each case, you will be asked to indicate how strongly you
> believe that the indicated controls either do or do not provide reason-
> able assurance that the control objectives of AUTHORIZATION and

VALIDITY will be met for cash disbursements. These objectives are defined as follows:

Authorization: all transactions are executed in accordance with criteria established by the appropriate level of management.
Validity: only economic events conforming to business principles as established by management are accepted as transactions and processed.

An example of the cash disbursement control questionnaire is presented in Table 1. Control number 4 (a, b, and c jointly) is a separation-of-duties control. Control number 5 is a preventive control and control number 6 is a detective control. These controls should at least partially compensate for a separation-of-duties weakness (if any exists).

INSERT TABLE 1 ABOUT HERE

Subjects

Subjects were 16 audit seniors with 3 to 4 years of audit experience.[11] The subjects were employed in the same large city office of a national CPA firm and volunteered to participate in response to a written request from their employer.

Research Design and Variables

Five of the six controls (numbers 1, 3, 4b and 4c jointly, 5 and 6) were factorially manipulated at two levels each (Yes or No) over 32 control cases (i.e., a 2^5 factorial design). Control numbers 2 and 4a were held constant (Yes) across the 32 cases. The representativeness of the internal control evaluation cases was increased through several mechanisms.[12]

The dependent variable was a subject's belief, for each of the 32 control cases, that the indicated control combination provides reasonable assurance that the objectives of authorization and validity will be met for cash disbursements. The subjects were asked:

>How strongly do you believe that the controls, as represented by this
>checklist segment, either DO or DO NOT provide reasonable assurance
>that the objectives of AUTHORIZATION and VALIDITY will be met
>for cash disbursements?

The responses were elicited on a 21-point scale where -10 was the maximum

belief that the controls DO NOT provide reasonable assurance of the objectives

being met, +10 was the maximum belief that the controls PROVIDE reasonable

assurance of the objectives being met, and 0 was indifference.

An ANOVA was determined for each subject which included all of the main

effects (5), all of the two-way interactions (10) and one three-way interaction

(separation-of-duties control by preventative control by detective control).

The remaining higher-order interactions (15) were used as an error estimate.

Within each subject's model, the omega-squared statistic was used to measure

the extent of explained variance for each term. Also for each subject, ver-

sions (generalized for five-cue situations) of equations (5) and (8) were used

to calculate the two supplemental configurality measures: compensation and

amplification as percents of theoretical maximum.[13]

Procedures

The laboratory session consisted of two sections, training and experiment.

Both sections were presented on personal computers in a 5-machine micropro-

cessing center (located in the employing firms' office). Subjects completed

both sections at their own pace (the average total time was 56.9 minutes).

The training section began with brief instructions on the use of personal

computers, and was followed by presentation of an internal control evaluation

case involving accounts receivable. This training case introduced the subject

to the response scale and two decision aids that would be used in the experi-

ment section.[14] Each subject evaluated five accounts receivable internal

control cases to practice using the response scale and the decisions aids.

The experiment section began with the cash disbursements internal control case presented earlier in this paper, and was followed by a blank copy of the cash disbursement control questionnaire. The subjects then responded to a series of questions designed to stimulate prior thought about relations between the cash disbursement controls listed on the questionnaire and the control objectives of authorization and validity. For each of the six listed controls, the subjects were asked:

1) Think about what could go wrong if that control were not present and things that could be prevented from going wrong if this control were present. Indicate the MOST SERIOUS thing that this control, if present, could prevent from going wrong.
2) Indicate the importance of this control with respect to the objectives of AUTHORIZATION and VALIDITY for cash disbursements.

Following these series of questions, the subject was presented with the 32 internal control cases. The order of the internal control cases was randomized for each subject. The order of the internal control items (on the questionnaire) was counterbalanced with one-half of the subjects receiving the order indicated in Table 2, and the other one-half of the subjects receiving controls 4(a, b and c), 5 and 6 prior to controls 1, 2 and 3 (appropriately renumbered).

Results

Configural Cue Usage As a Percent of Judgment Variance. Table 2 presents the results of averaging the omega-squared statistics over subjects (both for all terms and for only the significant [$p<.05$] terms), while Panel B of Table 3 presents selected omega-squared statistics for individual subjects. Although the main effects of the separation-of-duties and the preventive controls have the largest mean omega-squared statistics (46.2% and 26.2%, respectively), the interaction of these two controls has a significant mean omega-squared statistic of 4.5% ($t[15]=2.40$, $p<.03$ one-tailed). Ten out of the 16 subjects had individual omega-squared statistics that were significant ($p<.05$).[15] The

probability is less than .001 that one could sample from a population in which a true occurance rate was as low as 1/16 and obtain a sample occurance rate as high as 10/16 (a 95% confidence interval for the sample result of 10/16 would be [0.372,0.838]). Further, examining Table 2 reveils that no other information cue interaction was significant (p<.05) for as many subjects as was the hypothesized separation-of-duties by preventive control interaction. Thus, hypothesis one is confirmed by these results.

Hypothesis two predicted that the judgment variance attributable to the interaction of the separation-of-duties and detective controls would be significantly greater than zero. This interaction, however, has a non-significant mean omega-squared statistic of only .3%, and only one out of the 16 subjects had an individual omega-squared statistic that was significant (p>.05). Thus, hypothesis two is not confirmed by these results.

Hypothesis three predicted that judgment variance attributable to the interaction of the separation-of-duties and detective controls would be significantly smaller than that attributable to the interaction of the separation-of-duties and preventive controls. This hypothesis is confirmed: the mean omega-squared statistic for the interaction of the detective control with the separation-of-duties control is significantly smaller than that for the interaction of the preventive control with the same separation-of-duties control (paired t[15]=2.32, p<.04 one-tailed).

INSERT TABLES 2 AND 3 ABOUT HERE

Supplemental Configurality Measures. Panel A of Table 3 presents the supplemental configurality measures based on the judgments of each of the subjects. Examining the separation-of-duties and preventive control interaction, the means, averaged over all subjects, are significantly different from zero:

44.1% (t[15]=5.71, p<.01 one-tailed).   Further, for all 16 subjects the form
of the interactions is one of the two forms predicted (out of four possible
forms).   These results confirm hypothesis 4.   Although the separation-of-duties
and preventive controls interaction only accounted for an average of 4.5% of
the total variance in the subjects' control reliability judgments, this inter-
action averaged 44.1% of its theoretical maximum.   Consequently, on average the
cue patterns or configurations involving the separation-of-duties and preven-
tive controls appear to have been utilized by the auditor-subjects.   Whether
omitting the interaction during an evaluation of internal control reliability
would significantly affect subsequent audit costs (i.e., inefficiency due to
underreliance or ineffectiveness due to overreliance), however, is a matter for
future research.

Examining the separation-of-duties and detective controls interaction, the
means, averaged over all subjects, are significantly different from zero: 16.3%
for (t[15]=4.76, p<.01 one-tailed).   Further, for all 16 subjects the form of
the interactions is one of the two predicted (out of four possible forms).
These results confirm hypothesis 5.   Although the separation-of-duties and
detective controls interaction accounted for a significant portion of only one
subject's total control reliability judgments variance, for all subjects the
interaction averaged 14.6% of its theoretical maximum.   Again, however, deter-
mining if omitting the interaction during an evaluation of internal control
reliability would significantly affect subsequent audit costs, is a matter for
future research.

Hypothesis 6 predicted that the configurality measures for the interaction
of separation-of-duties and preventive controls would be smaller than those for
interaction of the separation-of-duties and detective controls.   This hypo-
thesis is confirmed by the results.   For the supplemental configurality

measures, the interaction involving the detective control is smaller than that involving the preventive control (paired t[15]=3.83, p<.01 one-tailed).

Additional Results. Examining the separation-of-duties and preventative controls interaction forms, nine subjects had a compensating form (i.e., negative ordinal) and seven had an amplifying form (i.e., positive ordinal). For those with a compensating interaction, the mean omega-squared was 7.3% and the mean supplemental configurality measures were 57.6% of theoretical maximum. For those with an amplifying interaction, the mean omega-squared was 0.8% and the mean supplemental configurality measures were 26.6% of theoretical maximum. For all configurality measures, the preventive control was perceived to be a significantly stronger compensator for a separation-of-duties weakness than it was an amplifier of a separation-of-duties strength.

Examining the separation-of-duties and detective controls interaction forms, ten subjects had a compensating form (i.e., negative ordinal) and six had an amplifying form (i.e., positive ordinal). In this situation, the supplemental configurality measures were larger, although not signficiantly, for the amplifying than for the compensating form of interaction. Thus, the detective control was perceived to be as strong an amplifier of a separation-of-duties strength as it was a compensator for a separation-of-duties weakness.

Concluding Remarks

This paper has discussed theoretical issues germane to configural information processing and has reported an experimental investigation of some of these issues. In particular, it has been argued that both contextual and cognitive factors must be considered in a search for configurality and that prior research generally has not addressed these factors. Further, prior research generally employed ANOVA designs which, for a variety of reasons, were shown to

be either inadequate detectors of configural information processing or not appropriately interpreted. Consequently, the primary purpose of this paper was to highlight these characteristics of the prior research and thereby, challenge the conventional wisdom that auditors' information processing can be well described by simple-form compensatory models.

Overall, the experimental results were consistent with expectations. Thus, when the experimental context was selected and analyzed so that theory could be used to guide the search for configurality, and supplemental configurality measures were employed, considerable evidence of configural information processing was produced. That is, the auditors' control reliability judgments, on average, were found to reflect the concept of compensating and amplifying controls which were shown to involve configurality. Consistent with the suggestion of process-tracing models (Einhorn, et al. [1979]), but unlike most policy-capturing studies, the present study has shown that for internal control evaluation (at least some) auditors' cognition involves configural cue usage. Note that evidence of configural cue usage was obtained for ordinal configural relations which for ANOVA models are more difficult to detect than are disordinal relations.

Although ordinal interactions, as reflected by the common discussion of compensating controls in CPA firm training materials, practice manuals and audit texts, may be expected to be quite common, disordinal interactions are not likely to appear in connection with the task of appraising internal control risk. Disordinal interactions, however, may be expected in other audit contexts. For example, within the context of planning analytical review, where the criterion is the probability that the current period's accounts receivable are presented in conformity with GAAP, the change in accounts receivable

(either an increase or no increase) and change in credit sales (either an increase or no increase) should produce a disordinal interaction.

Additional research is needed to replicate the present results which are based upon one task and a relatively small number of non-randomly selected subjects. Additionally, it is important to investigate the impact of cognitive factors. The potential impact of such factors may be highlighted by reexamining Panel A of Table 3 which reflects considerable variation across subjects both in the nature of the presumed configural relationship (compensating or amplifying) and the extent of such configurality. These individual differences likely are due to cognitive factors related to subject expertise, learning and memory that were not addressed in the present study.

Assuming that the reported results are not task/sample specific, the conventional judgment study characterization of auditors' cognition should be reconsidered. Such re-consideration is important from both research and practice perspectives. From the former perspective, answers to the fundamental questions of how and how well auditors process information may be quite different depending upon available evidence concerning their ability to process information configurally and thereby, incorporate concepts such as compensating and amplifying controls into their judgment policies. From the latter perspective, recent technological advances have enhanced the practical feasibility of expert systems and other computer-based judgment models. Such models should be based, however, upon the more sophisticated characterization of audit judgment formulation reflected herein than that in earlier studies.

APPENDIX A
Simulations of Configural Information Processing

Negative Ordinal Interactions

Judgments are simulated within a situation, analoguous to the left side of Figure 1, Panel B, in which: 1) judgments have continous values ranging from zero to ten, 2) two information cues, X_a and X_b, are available, each having two levels, present (level $\underline{1}$) and absent (level $\underline{2}$), 3) the presence of cue X_b compensates for the effect on judgment of the absence of cue X_a, 4) the judgments resulting from the cue combinations (X_{a1}, X_{b1}), (X_{a1}, X_{b2}) and (X_{a2}, X_{b1}) are each equal to ten, and 5) the judgments resulting from the cue combination (X_{a2}, X_{b2}) are maniputlated to produce various levels of compensation (as defined by equation [5] in the paper).

Figure 3 presents the results of the above simulations in which the variance attributable to each cue's main effect and their interaction is graphed as a function of the extent of cue X_bs compensation.[16] Examining Figure 3, as the extent of cue X_b's compensation (for cue X_a's absence) increases, the variance attributable to cue X_a's main effect decreases, and the variance attributable to both cue X_b's main effect and the two cue's interaction increases. However, the variance attributable to the interaction never exceeds that attributable to either of the two constituant cues.

INSERT FIGURE 3 ABOUT HERE

Positive Ordinal Interactions

Judgments are simulated within a situation analogous to the right side of Figure 1, Panel A, and similar to that above with the exceptions: 1) the presence of cue X_b amplifies the effect on judgment of cue X_a's presence, 2) judgments resulting from the cue combinations (X_{a2}, X_{b1}) and (X_{a2}, X_{b2}) are each equal to zero and combination (X_{a1}, X_{b2}) is equal to one, and 3) the judgments

resulting from cue combination (X_{a1}, X_{b1}) are manipulated to produce various levels of amplification (as defined by equation [8] in the paper).

Examining Figure 3, which also presents the results of the above simulations, as the extent of cue X_b's amplification (of cue X_a's presence) increases, the variance attributable to cue X_a's main effect decreases, and the variance attributable to both cue X_b's main effect and the two cue's interaction increases. Again, however, the variance attributable to the interaction never exceeds that attributable to either of the constituant cues.

FOOTNOTES

1. A few studies, discussed later, have reported exceptions to the general
   conclusion that human information processing is not configural.

2. This should not be interpreted to mean that all compensatory models are
   "simple" (see Einhorn, Kleinmuntz and Kleinmuntz [1979]). Rather, as dis-
   cussed later, the term "simple-form" compensating model is used to describe
   linear regression or ANOVA models in which terms that are reflective of
   configural cue utilization have not been included.

3. Anderson [1981, 1982] has argued that a lack of response scale linearity may
   have masked configurality in many studies.

4. The measure of explained variance used typically has been the omega-squared
   statistic (see Ashton [1982]).

5. Information cue orthogonality offers the advantage of allowing estimation of
   the explained judgment variance attributable to individual cues that is un-
   biased by cue interrelationships.

6. This illustration assumes a cell variance of 25 and a cell sample size of 2.
   The results will not change for larger cell size, and the relation of each
   term's explained variance to that of the other terms will not change if the
   within-cell variances are equal.

7. The focus in this paper, as discussed later, is the task of internal control
   evaluation. Since within this task, disordinal interactions are not expect-
   ed to occur, the supplemental measures deal strictly with ordinal interactions.

8. When either the numerator or the denominator equal zero, then an ordinal
   configural relation can be identified by the following inequality:
   $$[J(A_yB_y)-J(A_yB_n)] \; / \; [J(A_nB_n)-J(A_nB_y)] > 0.$$
   When both the numerator and denominator equal zero no configural relation
   exists.

9. These factors include the magnitude of distance D_2 (part of cue B's main
   effect) and the magnitude of the theoretical maximum compensation. Based
   on simulation results, both factors are related inversely with the ANOVA
   measures.

10. These factors include the magnitude of the distance D_2, the extent to which
    the D_2 interval is above the response scale minimum value, and the theoret-
    ical maximum amplification. Based on simulation results, the latter two
    factors are related directly with the ANOVA measures and the first has a U-
    shaped relation, direct than inverse.

11. Although 17 subjects participated in the experiment, one subject failed to
    complete appropriately the experimental tasks and was dropped from the sample.

12. First, earlier versions of the cases were pilot-tested with audit manager
    and other audit seniors in which the subjects were asked to indicate if any
    cue combinations were, in their opinions, implausible. Second, the case

instructions indicated that: 1) although the 32 cases are randomly ordered (i.e., the sequence in which they are seen has no meaning), the background information is common to all cases, 2) the cases present a mixture of possible internal controls: some indicate relatively strong controls, others indicate relatively weak controls, and still others indicate inter-mediate controls, 3) although in actual practice some cases may occur less frequently than others, the frequency of occurrence should not affect their assessments of control reliance, and 4) the internal control questionnaire is only partial, and is not intended to be in the form that the subject uses in actual audit engagements (i.e., the intention is to economically convey a range of possible cash disbursement control situations).

13. With respect to equations (5) and (8), cue A becomes the separation-of-duties control and cue B become either the preventive or the detective control. Thus, these measures average over the levels of all other cues.

14. The two decision aids were an electronic file of cases already evaluated and a logical consistency checker. When assessing the internal control cases, the subject had access to an electronic file of the cases that they had already evaluated. Past case evaluations could not be changed. As the subject worked through the internal control cases in the experiment sec-tion, the computer reviewed their assessments for logical consistency (i.e., dominance conditions). If the computer detected an apparant logical inconsistency, that fact was displayed and the subject had the option of either changing or maintaining their assessment of the current case.

15. Notice that some subjects' interaction omega-squared values are much larger than those typically reported in extant ANOVA-based internal control evalu-ation studies (for example, the separation-of-duties by preventative con-trol interaction omega-squared values of subjects 1, 6 and 9 ranged from 9.4% to 29.8% [see Panel B of Table 3]).

16. The explained variance measure is the contribution to total ANOVA model judgment variance. Since in all instances the model R^2 is 1.0, there is no difference between the contribution to variance measure and measures such as omega-squared.

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TABLE 1
Cash Disbursement Control Questionnaire

1. Are protective writing devices used to indicate
   amounts on checks?

2. Are properly approved vouchers required for check
   preparation?

3. Are check signers designated by the Board of Directors?

4. Are the persons who sign checks independent of:

   a. Purchasing and those requesting expenditures?

   b. Persons approving vouchers?

   c. Persons preparing the checks?

5. Is a second check signer required who is independent
   of all expenditure and cash disbursement functions
   and who scrutinizes the supporting documentation?

6. Does internal audit investigate payments made to payees
   not on an independently approved payee listing?

TABLE 2
Omega-Squared Statistics (in percent)
Averaged Over Individual ANOVA Models

SOURCE	All Terms*		Significant (p<.05) terms		
	MEAN	S.D.	MEAN	S.D.	n
A [Protective check writing devices used]	2.78	4.27	3.39	4.54	13
B [Check signers designated by Board of Directors]	6.53	12.39	9.38	14.20	11
C [Persons who sign checks independent of persons approving vouchers and persons preparing checks]	46.15	30.00	46.15	30.00	16
D [A second check signer required who is independent of all expenditure and cash disbursement functions and who scrutinizes the supporting documentation]	26.16	26.56	26.16	26.56	16
E [Internal audit investigates payments made to payees not on an independently approved payee listing]	3.69	3.14	3.69	3.14	16
A x B	0.24	0.79	3.20		1
A x C	0.31	0.46	0.90	0.54	4
A x D	0.26	0.43	0.15	0.21	2
A x E	0.02	0.05	0.20		1
B x C	0.69	1.34	2.48	1.78	4
B x D	0.40	0.84	1.43	1.24	4
B x E	0.18	0.39	1.10		1
C x D	4.48	7.51	7.08	8.59	10
C x E	0.28	0.57	1.70		1
D x E	0.36	0.72	2.00	1.13	2
C x D x E	0.28	0.76	1.40		1

*n = 16

TABLE 3

Individual Subject Statistics

	Panel A				Panel B					
	Configurality Measures				ANOVA Omega-Squared (%)					
	Preventive		Detective							
Subject	%(Max)	Type	%(Max)	Type	Sep. of Duties	Preven-tative	Intera-ction[a]	Detec-tive	Inter-action[b]	R^2
1	92.9	-	5.9	+	39.5	29.8	29.8*	0.2	0.0	99.8
2	30.6	-	2.6	-	70.7	7.5	2.0*	2.0	0.0	95.7
3	11.1	+	0.0	-	98.7	0.2	0.0	0.1	0.0	99.9
4	74.2	-	30.7	+	12.1	14.6	3.9*	2.9	0.5	92.2
5	18.9	+	3.8	-	42.3	16.1	0.0	11.8	0.0	93.3
6	98.7	-	7.3	-	9.9	64.0	9.4*	5.1	0.0	97.0
7	59.2	+	27.2	-	15.4	66.4	2.5*	1.9	0.0	94.4
8	57.7	-	9.8	+	18.6	21.7	2.9*	3.2	0.1	96.2
9	84.7	-	50.4	-	21.6	26.9	11.3*	7.2	1.7	87.8
10	20.0	+	22.2	-	0.5	96.3	0.0	0.2	0.0	99.6
11	6.2	-	12.0	-	80.3	4.6	0.0	2.7	0.1	96.2
12	29.6	+	22.6	+	70.1	8.3	0.8	5.6	0.3	96.5
13	34.8	-	29.7	-	58.0	23.2	2.5*	7.3	1.7*	98.7
14	44.6	+	18.3	+	62.1	11.4	2.7*	1.5	0.1	94.2
15	2.8	+	16.2	+	70.7	14.8	0.0	2.8	0.0	98.4
16	39.0	-	2.1	-	67.9	12.7	3.8*	4.5	0.0	96.5
MEAN	44.1		16.3		46.2	26.2	4.5	3.7	0.3	95.6
SD	30.9		13.7		30.0	26.6	7.5	3.1	0.6	3.7

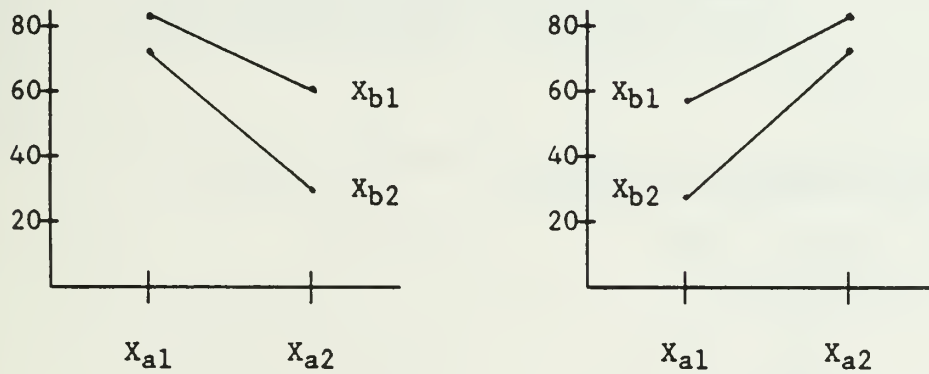[a] Separation-of-Duties by Preventative Control (*p<.05).
[b] Separation-of-Duties by Detective Control (*p<.05).

FIGURE 1
Types of Interactions

Panel A: Positive Ordinal Interactions
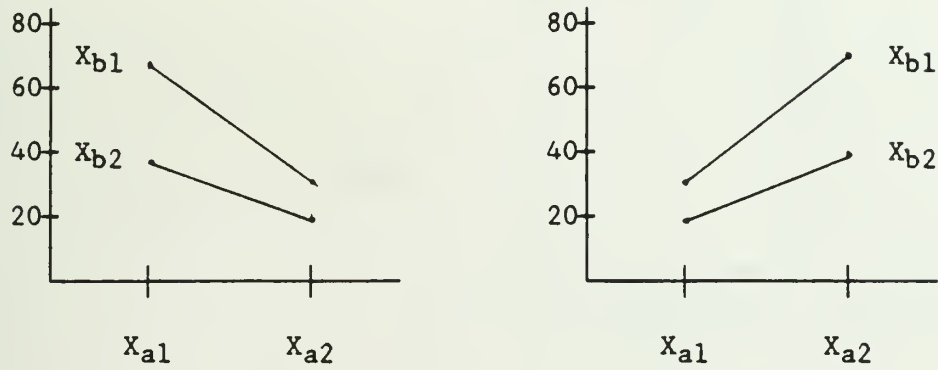
Panel B: Negative Ordinal Interactions

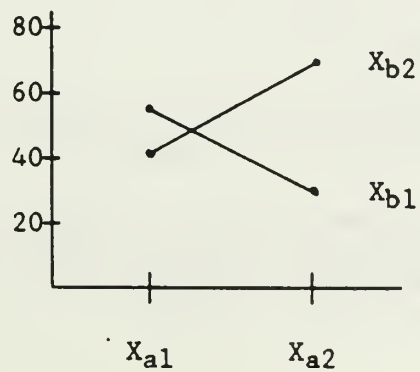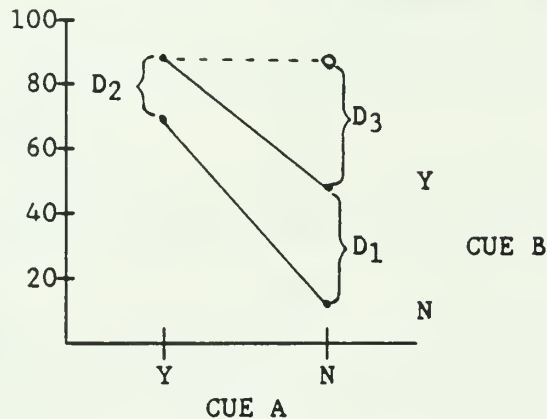Panel C: Disordinal Interaction

FIGURE 2
Supplemental Configural Information Processing Measures

Panel A: Negative Ordinal Relationship

$D_1 - D_2$ — Extent to which presence of cue B compensates for the effect on J of cue A's absence.

$D_1 - D_2 + D_3$ — Theoretical maximum compensation without changing the form of the configural relation and without changing cue A's effect on J given cue B's absence.
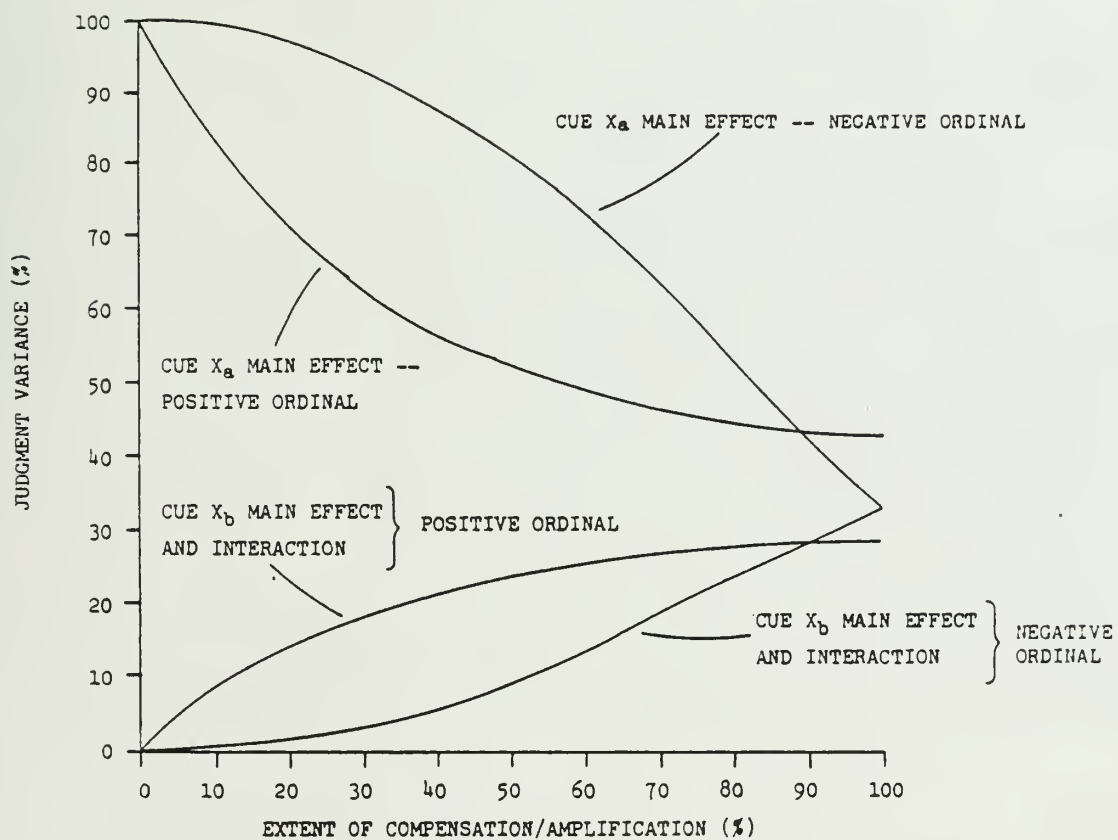
Panel B: Positive Ordinal Relationship
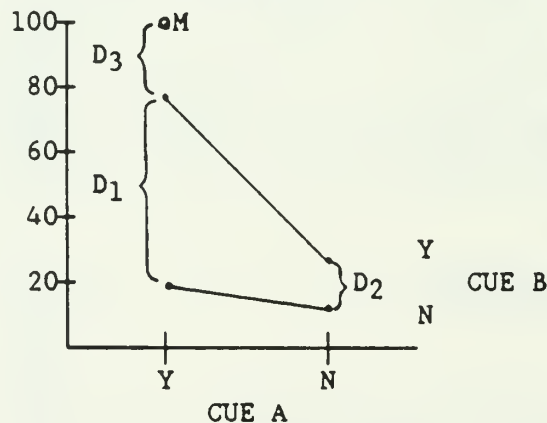
$D_1 - D_2$ — Extent to which presence of cue B amplifies the effect on J of cue A's presence.

$D_1 - D_2 + D_3$ — Theoretical maximum amplification without changing the form of the configural relation and without changing cue A's effect on J given cue B's absence.

FIGURE 3
Simulations of Configural Information Processing